

Population density and habitat selection of woodpeckers in mountain forests of the Northern Limestone Alps (Austria)

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Abstract: Densities and habitat requirements of woodpeckers that occur in the mountain forests of the Austrian Eastern Alps are described for a study area around the Nationalpark Kalkalpen, and compared with studies in other regions of Austria. All the woodpecker species that are treated, Three-toed Woodpecker, White-backed Woodpecker, Black Woodpecker, Grey-headed Woodpecker, Eurasian Green Woodpecker and the Great Spotted Woodpecker reached high densities in the study area in which patches of pristine forest and patches infested by bark beetles provide ideal conditions.

Key words: woodpecker abundance, habitat use, Austria, Northern Alps, *Picoides*, *Dendrocopos*, *Dryocopus*, *Picus*.

Introduction

This contribution focusses on the densities and habitat requirements of those woodpeckers that occur in the mountain forests of the Austrian Eastern Alps. It does not consider the Wryneck (*Jynx torquilla*), and species that mainly inhabit the lowlands, such as the Syrian Woodpecker (*Dendrocopos syriacus*), Lesser Spotted Woodpecker (*Dryobates minor*) and the Middle Spotted Woodpecker (*Leiopicus medius*).

Depending on the density and quality of habitat requisites, woodpecker densities can vary substantially. Territory sizes and hence population densities of birds depend critically on the quality of the habitats investigated (PASSINELLI 1999). Methodological differences, however, may result in divergent densities. Especially density estimates based on study plots too small in relation to territory size tend to overestimate abundances (BEZZEL 1982).

There is a lack of information on woodpecker habitat requirements and densities in the mountainous areas of Austria. This survey is intended to fill this gap. The focus is on the montane and subalpine forests in the Northern Limestone Alps of Upper Austria and Styria because this region has been the subject of much of our own work in the past decade (WEIBMAIR et al. 2006, 2008, PÜHRINGER & SULZBACHER 2008, GIGL & WEIBMAIR 2009, WEIBMAIR & PÜHRINGER 2011, 2012, WEIBMAIR 2011b, c, 2014). The mountain forests around the Dachstein, Totes Gebirge, and especially the Kalkalpen National Park visited in the course of

these studies constitute large continuous areas of pristine forest types little influenced by human activities. The densities of woodpeckers with exacting habitat requirements, such as the White-backed Woodpecker (*Dendrocopos leucotos*), Three-toed (*Picoides tridactylus*) and Grey-headed Woodpecker (*Picus canus*) are above average and their populations are important at least on a national scale.

Methods

Mapping

In the study plots, the target species were counted with „economized“ territory mapping, with three visits per site (BIBBY et al. 1995; note that this reduced effort method was not mentioned in the original version of this book). Territories were usually mapped in a period of two to three days with the researches staying there overnight (Fig. 1). Birds were searched from sunrise to the late morning.

A special feature of these surveys was recording bird presence simultaneously on large study plots. Depending on plot size, two, but mostly three to four and sometimes up to seven persons distributed equally over the plot mapped the woodpeckers simultaneously. A person had therefore to search an area of 80 to 120 hectares in one morning. This method yields significantly better results with respect to finding and outlining territories than the usual method of censusing relatively small plots by single persons.



Fig. 1: Bivouac site in the plot Mayralm, Nationalpark Kalkalpen, 6 April 2009. Photo: W. Weißmair.



Fig. 2: Plot Arikögele still deeply covered with snow, Dachstein 11 April 2007. Photo: W. Weißmair.

The size of the plots and the sometimes difficult accessibility (steepness, impassability, risk of avalanches, and so on) were good reasons for visiting the plots three to four times only when weather conditions were fine between end of March and begin of June.

When woodpeckers were not very active, acoustical signals of woodpeckers were played back using powerful yet light-weighted audio-equipment (CD-player, MP3-player, iPods and loudspeakers). These acoustic lures were used sparingly and stopped immediately when a woodpecker responded. The available digital recordings, especially those of drumming rolls, vary greatly in quality and volume. Thus, various sources had to be

used: ROCHÉ (1995), SCHULZE (2003), BERGMANN et al. (2008). Calls of the Grey-headed Woodpecker could also be imitated by whistling.

Briefings took place before each mapping round. Plots were assigned to individual team members, and the participants discussed access routes and the associated hazards (avalanches, roughness of forest roads, adverse trail conditions), and fixed listening posts and bivouac locations. It turned out that debriefings, in which the participants discussed doubtful observations or possible double counts, were very useful too. Most of the issues could be clarified in these consultations.

Snow covered the plots early in the year. Thus the observers with their heavy back-packs had to be on skies or snow-shoes to cover the study plot recently. To avoid double counts and for a more reliable designation of territorial boundaries, team members stayed in permanent contact via handheld CB radios or cell phones. The operation of the CB radios is free of charge and had the additional advantage that reception most of the time was better than with cell phones, except when some kind of a barrier (ridge) interfered.

The method of simultaneous censuses turned out to be efficient. Especially when woodpecker densities were high, like for instance at the Feichtau site, this was the only way to delineate territorial boundaries. However, on very steep or mountainous terrain it was not always possible to localize the woodpeckers exactly. Under these circumstances double counts could be excluded for certain, and the possibility of having overlooked some territory holders remained. The team surveyed even the larger plots (Mayralm 575 ha and Bodinggraben 530 ha) in one piece to avoid double counts.

Observations were most fruitful at dawn. The early morning hours to about eleven also yielded good results most of the time. In the course of the owl censuses which were also part of the monitoring activities, it appeared that woodpeckers were less noticeable when dusk approached. However, woodpecker activity did not always follow this pattern of maximal activity in the early morning hours under fine weather conditions. All woodpecker species were very active on some days that could rightly be called „woodpecker days“. For reasons unknown to us, it still could happen that woodpeckers showed little activities on the days before or thereafter despite comparable weather conditions.

In addition to our own data gathered in these surveys and which form the main base for our results about densities and habitat preferences, data from several other sources were considered. In some cases we went back to the study plots to check nest cavities, among other things. In addition, we considered observations by

other people working for the national forestry service (ÖBf), the national park (collected in their wildlife data base) and data found in the zoogeographical data base Zobodat at the Biologiezentrum, Upper Austrian state museums.

Analyses

All observations made in the course of the fieldwork were entered into base maps, one for each day and species, according to the requirements of the territory mapping method. Locations were determined as accurately as possible either by GPS fixes or marking them on the base map and also entered in a field log. The latter were then transferred to a spread sheet. After each survey, registrations were transferred to a separate summary map for each species, and clusters of registrations on such a map were assumed to represent one individual territory. Single observations and the locations of territory centres were collected in point shape files (ArcGIS 10 and earlier versions) and corresponding attribute files using the maps and orthophotos provided by the commissioner.

Records were coded according to the recommendations of the European Ornithological Atlas Committee (EOAC-Code, DVORAK et al. 1993), with the categories „Present (but no indication of breeding)“, „Possible breeding“, „Probably breeding“ and „Confirmed breeding“. In addition to the data on the spatial distribution of the target species, habitat use, phenology, local characteristics and other interesting observations were also collected. These data were always linked to the original observations of the mapping project at exactly specified locations. Within the Nationalpark Kalkalpen, it was possible to use a GIS to combine observations with the data of the forest inventory that cover the area almost completely, and hence to get information on stand age. The digital elevation model of the national park allowed to generate data on slope exposition, steepness, and also was useful to check the elevation data obtained via the base maps.

Study area and plots

Table 1 summarises the most important features of the study plots and informs about the surveying year. More details can be found in several publications and reports: Upper Austrian Dachstein and Eibenberg near Ebensee: GIGL (2006), GIGL & WEIBMAIR (2009), European Reserve (Natura 2000, bird reserve) Dachstein (Upper Austria) WEIBMAIR et al. (2008), WEIBMAIR & PÜHRINGER (2011), WEIBMAIR (2011b), Nationalpark Kalkalpen: WEIBMAIR (2014), European Reserve (bird reserve) Totes Gebirge (Styria): WEIBMAIR & PÜHRINGER (2012). PÜHRINGER & SULZBACHER (2008) did not

Tab. 1: Year of investigation and characteristics of the 26 study plots with simultaneous mapping of woodpecker species in the Northern Limestone Alps (7656 ha total). Main-Exposure: N=North, E=East, S=South, W=West.

Study area and plots	Area [ha]	Altitude [m]	Exposition	Slope [°]	Surveying year
Nationalpark Kalkalpen					
Bodinggraben	533	620-1440	SW, NW	31	2011
Wilder Graben	497	430-1000	NW, SE	29	2009
Große Schlucht	309	500-1080	S, W	36	2010
Holzgraben	522	730-1490	NE, SW	29	2010
Spering-Lackerboden	314	500-1570	SW	32	2011
Feichtau	490	1160-1560	NW, SE	24	2010
Mayralm	577	980-1670	SE	22	2009
Total	3242				
Dachstein and Eibenberg/Upper Austria					
Lärchkogel	131	940-1400	SW		2005
Hochalm	150	1400-1650	SW		2005
Modereckalm	132	1300-1550	N		2005
Seekaralm	372	1350-1650	N		2005
Scharwandhütte	100	1250-1800	N		2005
Hirschbrunn-Kessel	96	550-900	N		2005
Winkler Berg	151	520-1300	NW		2005
Sulzgraben	110	600-1100	N		2005
Koppenwinkel	165	530-800	NW		2005
Eibenberg	163	1300-1550	N		2005
Total	1569				
European Reserve Dachstein/Upper Austria					
Gosauseen	300	950-1500	SW-NE		2006
Seekaralm	300	1200-1650	NW-NE		2007
Arikögele	300	1250-1770	NE		2007
Krippenbrunn	400	750-1770	N-NE		2006
Schönbergalm	120	700-1650	N		2006
Total	1420				
European Reserve Totes Gebirge/Styria					
Altaussee	380	715-1360	SE - NW		2009
Grundlsee	235	840-1360	S-SE		2009
Schwarzenberg	430	800-1540	SW - SE		2011
Toplitzsee	380	710-1310	SE-SW		2011
Total	1425				

use simultaneous mapping in their Nationalpark Kalkalpen study. These data were therefore only used for the analyses of habitat relationships, but not included in the analyses of breeding densities.

Nationalpark Kalkalpen

The study in the national park is special because of the size of the individual study plots (e.g. Mayralm 577 ha) and the total area surveyed (3,242 ha). Additional studies on owls (Strigidae) and flycatchers (Muscicapidae) were conducted in the same plots resulting in an excellent data resource. The plots were representative with respect to the elevations in the region, only elevations between 1000 and 1200 m are somewhat underrepresented, and forests between 1200 and 1400 m overrepresented (the large plots Feichtau and Mayralm



Fig. 3: Plot Schwarzenberg, Totes Gebirge 20 May 2011. Photo: N. Pühringer.



Fig. 4: Plot Große Schlucht, Nationalpark Kalkalpen 26 May 2010. Photo: W. Weißmair.



Fig. 5: Plot Spering, Nationalpark Kalkalpen 30 March 2011. Photo: N. Pühringer.

that we were obliged to incorporate belong to this zone). With respect to slope one would expect that because of avalanche risk and difficult accessibility gentler slopes were preferred, but this was not the case.

It could be proved that many sections of the national park forests had been harvested only once, or that the last logging had been long ago. The forests of the national park therefore present themselves as rather pristine and offer favourable habitats for woodpeckers, as well as for owls or flycatchers and other rare and/or threatened bird species. In the course of a survey of the habitats of the park eight areas were discovered which very probable constitute primeval forest remnants. They represent mainly beech, beech fir, and small patches of natural Norway spruce forests covering a total area of about 138 ha. All forests in the Nationalpark Kalkalpen are principally not used by forestry any more. The forests in the national park are much closer to natural conditions than average Austrian forests. Moderately altered forests account for 29% and heavily modified forests for only 4% of the total forested area and their proportion decreases year by year. Natural and semi-natural forests cover 67% of the total area. This is three times as much as in the total forest area of Austria (21%). Stocktaking of the natural resources in the Nationalpark Kalkalpen revealed that the average age of the forest stands is about 124 years (see WEISSMAIR 2014). Austrian commercial forests contain 6.1 m³ solid dead wood on average. About 15 m³ of solid dead wood per hectare were measured in the national park in 1995, and the value had increased to approximately 30 solid m³/ha by 2010. The most important reason for this development was the recent storms and the ensuing bark beetle outbreaks. The amount of dead wood will probably increase further in the years to come. It is reasonable to assume that those forest dwelling bird species that profit from high amounts of dead wood, such as woodpeckers, will experience further improvements of their habitats simply because commercial forestry has been banned from the park.

Results and discussion

Species composition and number of territories

Six woodpecker species occurred and held territories on a regular basis in the 26 study plots in the northern limestone Alps of Upper Austria and Styria. Beginning with the least abundant species, these were Eurasian Green, Black, Grey-headed, White-backed, Great Spotted and Three-toed Woodpecker (Tab. 2). The different habitat suitabilities, weather conditions and those encountered during the surveys (snow cover) and other

Tab. 2: Number of woodpecker-territories at the 26 study plots (7656 ha) in the Upper-Austria and Styria Northern Limestone Alps.

Study areas and plots	Area [ha]	Three-toed Woodpecker	White-backed Woodpecker	Black Woodpecker	Grey-headed Woodpecker	Eurasian Green Woodpecker	Great Spotted Woodpecker	Total
Nationalpark Kalkalpen								
Bodinggraben	533	8.5-9.5	7.5-8.5	3-4	3-4	-	13.5-14.5	35.5-40.5
Wilder Graben	497	5-6	7.5-10.5	3-4	3-3.5	1.5	4.5-7.5	24.5-32
Große Schlucht	309	5	6-7	2.5	2.5-3.5	1	4-5	21-24
Holzgraben	522	8.5-10.5	7-8	4	3.5	-	6-9	31-37
Spering-Lackerboden	314	4-5	1	3	2.5-3.5	1	5.5-7.5	17-21
Feichtau	490	15-17	1	-	2	1-2	9-11	28-32
Mayralm	577	8.5-9.5	1	1	1	-	10.5-12.5	22-25
Sub-total	3242	54-62.5	31-37	16.5-18.5	17.5-21	4.5-5.5	53-67	
Dachstein and Eibenberg/Upper Austria								
Lärchkogel	131	2	-	2	-	-	3	7
Hochalm	150	3-4	-	-	-	-	-	3-4
Modereckalm	132	2	-	-	-	-	-	2
Seekaralm	372	2-3	-	-	-	-	2-3	4-6
Scharwandhütte	100	1	-	-	1	-	-	1
Hirschbrunn-Kessel	96	-	-	1	1	1	1-2	4-5
Winkler Berg	151	2	-	1-2	2	-	2	7-8
Sulzgraben	110	-	-	1	-	-	-	1
Koppenwinkel	165	-	-	-	-	-	-	1
Eibenberg	163	3-4	-	1-2	-	-	1	4-6
Sub-total	1569	15-18	-	6-8	4	1	9-11	
European Reserve Dachstein/Upper Austria								
Gosauseen	300	3	1-2	0.5	2-3	-	-	6.5-8.5
Seekaralm	300	3.5-5.5	-	0.5	-	0.5	4-6	8.5-12.5
Arikögele	300	4-7	-	0.5	2	0.5	3.5	10.5-13.5
Krippenbrunn	400	5.5-6.5	1	1.5	2.5	-	5.5-7.5	16-18
Schönbergalm	120	-	1	-	0.5	-	2	3.5
Sub-total	1420	16-22	3-4	3	7-8	1	15-19	
European Reserve Totes Gebirge/Styria								
Altaussee	380	8-9	1.5	2	1.5	2	6	21-22
Grundlsee	235	5	3	2.5	3	2	7-8	22.5-23.5
Schwarzenberg	430	-	1-2	1-2	2	2.5	3.5	10-12
Toplitzsee	380	2	4-5	2.5	4	2	2.5	17.5-18.5
sub-total	1425	15-16	10-11	8-9	10.5	8.5	19-20	
Total	7656	100-118.5	44-52	33.5-38.5	39-43.5	15-16	96-117	

factors explain this ranking. The Eurasian Green Woodpecker, for instance, despite being the least common species is not threatened at all because mountain forests principally offer little suitable habitat and this woodpecker cannot establish themselves there in years of deep snow cover. The reasons for the Three-toed Woodpecker being the most common species are the high (and unnatural) portion of spruce in many of the forests and above all the bark beetle outbreaks in the aftermath of the gales „Kyrill“ , „Emma“ and „Paul“ in the last decade.



Fig. 6: Avalanche swaths like the depicted one are very dynamic habitats and supply lots of dead wood essential for practically all mountain forests woodpecker species. Near Grundlsee, Totes Gebirge. Photo: W. Weißmair.



Fig. 7: Bark beetle infected spruce are Three-toed Woodpeckers' paradise; Bodinggraben, Nationalpark Kalkalpen. Other woodpecker species also utilize such patches, even the White-backed Woodpecker. Photo: W. Weißmair.



Fig. 8: Three-toed Woodpecker. Photo: N. Pühringer.

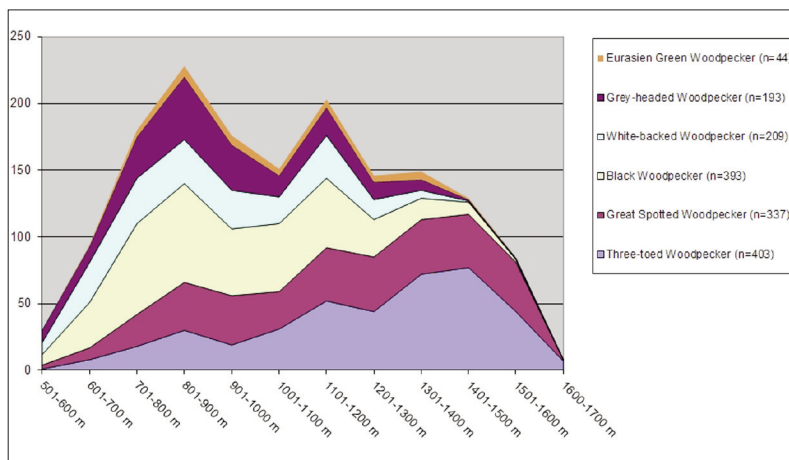


Fig. 9: Altitudinal distribution of the six woodpecker species on 26 study plots in the Northern Limestone Alps of Upper Austria and Styria.

The diploma thesis work conducted in the regions Upper Austrian Dachstein and Eibenberg (GIGL 2006, GIGL & WEIBMAIR 2009) focused on the niche partitioning of Three-toed and Great Spotted Woodpecker which guided study plot selections and explains to some degree the complete lack of White-backed Woodpeckers records. This species turned out to be relatively uncommon also in a later survey. WEIBMAIR & PÜHRINGER (2011) reasoned that this Natura 2000 site offers little suitable habitat.

Habitat descriptions and woodpecker densities

Three-toed Woodpecker (*Picoides tridactylus*)

Status: Austrian Red List: Least Concern (FRÜHAUF 2005), EU: Appendix I.

With the exception of Vienna and the Burgenland, this species breeds regularly in all Austrian states. Its main stronghold are the alpine regions, isolated populations exist in the Upper and Lower Austrian parts of the Bohemian Massif (DVORAK et al. 1993, WEIBMAIR 2003). Breeding records range between about (600) 700 m to almost 1,900 m a.s.l. (KILZER et al. 2011, SACKL & SAMWALD 1997), with this species becoming significantly commoner above 1000m a.s.l. in suitable forest types.

The Three-toed Woodpecker inhabits mainly autochthonous montane and subalpine spruce forests and avoids the spruce forests of the Alpine foothills. Its main food are the various stages of bark and long horn beetles, corresponding high proportion of dying or dead spruce trees is therefore of an essential for its occurrence and density. It may appear in small patches of spruce within mixed forests with a high proportion of deciduous trees, even at low elevations, during severe bark beetle outbreaks as, for instance, in the Wilder Graben between 600 and 700 m (Nationalpark Kalkalpen, NPK). The Three-toed Woodpecker frequently foraged in Scots pines (*Pinus sylvestris*) around the Große Schlucht (NPK). However, it hardly used larch stands (*Larix decidua*) during the breeding season. In the areas studied, most of the Three-toed Woodpeckers occurred between 1100 and 1500 m (Fig. 9).

Surveys in the mountains during the courtship period April to May are demanding because of the still prevailing wintry conditions and hence scarce. This species also reacts to playbacks not all the time. Meanwhile, several in-depth studies on breeding density (and habitat selection) are available (GIGL & WEIBMAIR 2009, WEIBMAIR et al. 2008, WEIBMAIR & PÜHRINGER 2011, 2012, WEIBMAIR 2011b, c, 2014). Table 3 summarises the results concerning the breeding densities based on data from the 26 study plots.

Generally speaking, Three-toed Woodpeckers need large homeranges and their densities are low (PECHACEK 2004). Nest cavities can be anywhere in the territory of which only a small part with high food availability is intensively utilized in the breeding season. Densities increase substantially during bark beetle outbreaks like in the National Park “Bavarian Forest” (SCHERZINGER 1982) and in the Nationalpark Kalkalpen (WEIBMAIR 2014).

Taken all the 26 Upper Austrian and Styrian plots together (7,656 ha), the density was a remarkable 1.3 to 1.5 territories/100 ha (Tab. 3); excluding plots in which the species was not found, the density amounted to 1.4 to 1.7 territories/100 ha. The high densities in the Nationalpark Kalkalpen (1.7-1.9 territories/100 ha) contributed substantially to these figures. Densities in the Dachstein plots were somewhat lower (about 1.1-1.5 territories/100 ha) (WEIBMAIR et al. 2008, WEIBMAIR & PÜHRINGER 2011), but still significantly above the one territory/100 ha expected according to published data and our own experience in other regions. The densities in optimal habitats on the plateau of the Nationalpark Kalkalpen, old montane spruce stands heavily infested with bark beetles, were even higher. We found 2.5 to 5.3 territories/100, top values for Central Europe, in places like Feichtau, Bodinggraben (Trämpl-Scheiterkogel), or Holzgraben (south facing slopes of the Astein-Quenkogel). In these cases territories were smaller, approximately 20-30 ha. Territory centres were remarkably in or close to clusters of bark beetle infected trees. Park rangers reported that bark beetle infestations have meanwhile reached normal levels, with few new bark beetle attacks. The decisive factor for this development was the fact that the last years were free of major catastrophic events. We suspect that the unusually high densities of especially the Three-toed Woodpecker are significantly reduced by now. There are no monitoring data to confirm this trend, but spot checks of the plots Feichtau and Mayralm support this conclusion. Taken all together, the Three-toed Woodpecker may be among the losers of climatic change when its indirect effects lead to the dieback of large, continuous mountain spruce forests (PECHACEK 2009).

HOCHEBNER et al. (2015) found 1.42 territories/100 ha in 13.38 km² forest of the Dürrenstein wilderness reserve in the years 2013 and 2014. This corresponds to the overall average in the Northern Limestone Alps, but is significantly lower than, for instance, in the Nationalpark Kalkalpen (1.7-1.9 territories/100 ha, Tab. 4). On a smaller scale and especially in bark beetle infested patches, densities in this reserve were clearly higher and like those found in the Nationalpark Kalkalpen (plot Kleiner Urwald, 109.6 ha: 2.74 territories/100 ha; plot Hundsau 5.33 – 6.22 territories/100 ha).

Tab. 3: Number of territories and abundances of the Three-toed Woodpecker on the 26 study plots (7656 ha) Upper-Austria and Styria Northern Limestone Alps. With average densities in the four study areas the results of all study plots and only sample plots are differentiated with woodpecker evidences.

Study areas und plots	Area [ha]	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	8.5-9.5	1.6-1.8
Wilder Graben	497	5-6	1.0-1.2
Große Schlucht	309	5	1.6
Holzgraben	522	8.5-10.5	1.6-2.0
Spering-Lackerboden	314	4-5	1.3-1.6
Feichtau	490	15-17	3.0-3.5
Mayralm	577	8.5-9.5	1.5-1.6
Sub-total(all plots)	3242	54-62.5	1.7-1.9
Sub-total (plots with 3-T Woodpeckers)	3242	54-62.5	1.7-1.9
Dachstein and Eibenberg/Upper Austria			
Lärchkogel	131	2	1.5
Hochalm	150	3-4	2.0-2.7
Modereckalm	132	2	1.5
Seekaralm	372	2-3	0.5-0.8
Scharwandhütte	100	1	1.0
Hirschbrunn-Kessel	96	-	-
Winkler Berg	151	2	1.3
Sulzgraben	110	-	-
Koppenwinkel	165	-	-
Eibenberg	163	3-4	1.8-2.5
Sub-total (all plots)	1569	15-18	0.95-1.1
Sub-total (plots with 3-T Woodpeckers)	1198	15-18	1.0-1.1
European Reserve Dachstein/Upper Austria			
Gosauseen	300	3	1.0
Seekaralm	300	3.5-5.5	1.2-1.8
Arikögele	300	4-7	1.3-2.3
Krippenbrunn	400	5.5-6.5	1.4-1.6
Schönbergalm	120	-	-
Sub-total (all plots)	1420	16-22	1.1-1.5
Sub-total (plots with 3-T Woodpeckers)	1300	16-22	1.2-1.7
European Reserve Totes Gebirge/Styria			
Altaussee	380	5	1.3
Grundlsee	235	-	-
Schwarzenberg	430	8-9	1.9-2.0
Toplitzsee	380	2	0.5
total/densities all plots	1425	15-16	1.0-1.1
plots species occurred	1190	15-16	1.2-1.3
Total (all plots)	7656	100-118.5	1.3-1.5
Total (plots with 3-T Woodpeckers)	6930	100-118.5	1.4-1.7

TEUFELBAUER (2010) found 1.03 territories/100 ha in an area of 11.11 km² in the Nationalpark Gesäuse, significantly fewer than in our surveys. In a second round, TEUFELBAUER et al. (2011) registered 0.76 territories/100 ha in 9.84 km² (three plots sized 402, 252 and 330 ha, two of them new and one as in TEUFELBAUER (2010)) an even lower density. In a survey by

Tab. 4: Comparison of large-scale abundances (territories/100 ha) of the Three-toed Woodpecker from the Austrian Alpine region on contiguous plots from about 500 ha. In the own investigations only those with simultaneous acquisitions found input. Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria, Vbg=Vorarlberg.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	1.3-1.5	current study
Nationalpark Kalkalpen	Oö	32.4	1.7-1.9	WEIßMAIR 2014
Dachstein and Eibenberg	Oö	15.7	0.9-1.1	GIGL & WEIßMAIR 2009
Vogelschutzgebiet Dachstein	Oö	14.2	1.12-1.55	WEIßMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	1.0-1.1	WEIßMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	10.88	1.2	FRANK & HOCHBNER 2001
Wildnisgebiet Dürrenstein	Nö	13.39	1.42	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	1.03	TEUFELBAUER 2010
Nationalpark Gesäuse	Stmk	9.84	0.76	TEUFELBAUER et al. 2011
Nationalpark Gesäuse	Stmk	6.54	0.61	WIRTITSCH et al. 2013
Vogelschutzgebiet Karwendel Tyrol	Tyrol	48	0.75-0.77	OBERWALDER et al. 2014
Karwendel Teilgebiet	Tyrol		0.78-0.8	OBERWALDER et al. 2014
Brandnerberg	Tyrol	5	0.8-1.0	PFANDL et al. 2004
Klostertal	Vbg	15	0.7	KILZER 1996

WIRTITSCH et al. (2013) (two plots totalling 654 ha) these values sank to 0.61 territories/100 ha.

KILZER (1996) detected 0.7 territories/100 ha on 1500 ha of old mountain forest (including deciduous

stands) in the Klostertal, Vorarlberg. RUGE & WEBER (1974) found only 0.4 territories/100 ha on a large area (11.4 km²) in the Eisenerzer Alpen (Styria).

OBERWALDER et al. (2014) surveyed seven plots (almost 4800 ha in total) in Karwendel mountain range in Tyrol. They calculated an average density of 0.75-0.77 territories/100 ha, including plots that did not hold any territories. The average density on plots suitable for the woodpecker was 0.78-0.8 territories/100 ha. This value is below the average when compared with our region or other reserves. The plot Arzl-Rum-Thaur was the most sparsely inhabited one (0.16 territories/100 ha), the highest density was recorded for the Vomperloch with 1.29-1.39 territories/100 ha.

MAUMARY et al. (2007) found only 3-4 territories in an area of 11 km² in the Canton of Schwyz, Switzerland. Further averages over very large areas in the Swiss Alps were 11-13 territories per 100 km², corresponding to densities of only 0.22-0.13 territories/100 ha (HESS 1983). The homeranges covered areas of about 50 to 200 ha (R. HESS referenced in GLUTZ von BLOTZHEIM & BAUER 1994).

Grey-headed Woodpecker (*Picus canus*)

Status: Austrian Red List: Near Threatened (FRÜHAUF 2005), EU: Appendix I.

The Grey-headed Woodpecker breeds patchily in all parts of Austria. Especially the populations of the Alpine foreland in Austria and Bavaria have declined substantially. Populations of the Alpine foothills and Limestone Alps seem not to have experienced serious changes. These areas form the stronghold of the species in Upper Austria (DVORAK et al. 1993, STADLER 2003).

In the Northern Limestone Alps, the Grey-headed Woodpecker inhabits semi-open deciduous and mixed forests. Because ants constitute its main food source, sunny habitats with little snow and high ant densities are essential. A strong preference for east to west facing slopes is clearly discernible. Forests that are occupied by Grey-headed Woodpeckers are often structured by windfalls and clearings; steep, rocky slopes or swathes caused by avalanches are often free of snow even in winter. Grey-headed Woodpeckers occurred mainly from the lowland to about 1200 m elevation; records further above were scarce (Fig. 9).

In the Northern Limestone Alps of Upper Austria and Styria, densities of the Grey-headed Woodpecker evaluated over a large area (7,656 ha) reached only medium values, namely 0.5-0.6 territories/100 ha (Tab. 5). Densities in the Nationalpark Kalkalpen, with its unspoiled and dead wood rich forests, computed as average of all plots were similar; taking only those plots into



Fig. 10: A pair of Grey-headed Woodpeckers. Photo: W. Weißmair.

account that were suitable for the species (2,175 ha, without the subalpine coniferous forests of the Feichtau and Mayralm) the resulting densities were 0.67-0.83 territories/100 ha. The plot in the Wilder Graben seemed to have been especially suitable: 2.5 territories were registered in 200 ha what corresponds to a density of 1.25 territories/100 ha; on the southern side of the Kieneck, in the plot Große Schlucht, the density, 1.5 territories/100 ha, was above average. Locally high densities were also found in the Dachstein sites (1.15 Territories/100 ha on 347 ha, GIGL & WEIBMAIR 2009).

OBERWALDER et al. (2014) determined a mean density of 0.69-0.82 territories/100 ha in the Tyrolian Karwendel, calculated from the results from seven plots (total area almost 4,800 ha), whereby not all plots were occupied (Tab. 6). The plot Achenwald had the lowest density (0.37-0.44 territories/100 ha), plot Zirl, with 1.69-2.4 territories/100 ha, the highest. The average computed over all the plots suitable for the Grey-headed Woodpecker was 0.76-0.9 territories/100 ha, therefore only marginally higher than in the Nationalpark Kalkalpen.

PFANDL et al. (2010) determined a density of 0.7 territories/100 ha on the Brandnerberg in the Tyrolian Rofan-mountains in a 500 ha forest area between 750 and 1600 m.

Higher densities are known to occur in the wilderness reserve Dürrenstein. HOCHBNER et al. (2015) found in a total area of 13.33 km² 12 territories or a density of 0.90 territories/100 ha in the years 2013 und 2014. However, plots were rather small and densities varied greatly among them. A density of 1.63 territories/100 ha was calculated for the 612.7 ha plot Hundsau and only 0.28 territories/100 ha for the 725.8 ha plot in the Rothwald.

High densities were also found in the Klostertal in Vorarlberg (2.0 territories/100 ha, KILZER 1996).

The densities determined for the Nationalpark Gesäuse on an 11.11 km² plot were substantially lower (0.31 territories/100 ha, TEUFELBAUER 2010). In a subsequent mapping effort, TEUFELBAUER et al. (2011) surveyed 9.84 km² (three plots with 402, 252 and 330 ha, two of them new and one as in the previous survey) and obtained a slightly higher density of 0.46 territories/100 ha, corresponding roughly with our own data. The monitoring project of WIRTITSCH et al. (2013) yielded 0.76 territories/100 ha (two plots totalling 654 ha).

WAGNER (2009) reported a density of 0.3-0.4 territories/100 ha from a 45.5 km² forest area in the bird reserve Schütt-Dobratsch, Villacher Alpe, Carinthia.

According to the handbook by GLUTZ VON

Tab. 5: Number of territories and abundances of Grey-headed Woodpecker at the 26 study plots (7656 ha) in the Upper-Austria and Styria Northern Limestone Alps. With average abundances in the four study areas the results of all study plots and only sample plots are differentiated with woodpecker evidences.

Study areas und plots	Area [ha]	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	3-4	0.6-0.8
Wilder Graben	497	3-3.5	0.6-0.7
Große Schlucht	309	2.5-3.5	0.8-1.1
Holzgraben	522	3.5	0.7
Spering-Lackerboden	314	2.5-3.5	0.8-1.1
Feichtau	490	2	0.4
Mayralm	577	1	0.2
Sub-total (all plots)	3242	17.5-21	0.5-0.6
Sub-total (plots with G-h Woodpeckers)	3242	17.5-21	0.5-0.6
Dachstein and Eibenberg/Upper Austria			
Lärchkogel	131	-	-
Hochalm	150	-	-
Modereckalm	132	-	-
Seekaralm	372	-	-
Scharwandhütte	100	1	1.0
Hirschbrunn-Kessel	96	1	1.0
Winkler Berg	151	2	1.3
Sulzgraben	110	-	-
Koppenwinkel	165	-	-
Eibenberg	163	-	-
Sub-total (all plots)	1569	4	0.3
Sub-total (plots with G-h Woodpeckers)	347	4	1.15
European Reserve Dachstein/Upper Austria			
Gosauseen	300	2-3	0.7-1.0
Seekaralm	300	-	-
Arikögele	300	2	0.7
Krippenbrunn	400	2.5	0.6
Schönbergalm	120	0.5	0.4
Sub-total (all plots)	1420	7-8	0.5
Sub-total (plots with G-h Woodpeckers)	1120	7-8	0.6
European Reserve Totes Gebirge/Styria			
Altaussee	380	1.5	0.8
Grundlsee	235	3	0.9
Schwarzenberg	430	2	0.3
Toplitzsee	380	4	1.0
Sub-total (all plots)	1425	10.5	0.8
Sub-total (plots with G-h Woodpeckers)	1425	10.5	0.8
Total (all plots)	7656	39-43.5	0.5-0.6
Total (plots with G-h Woodpeckers) 6134		39-43.5	0.6-0.7

BLOTZHEIM & BAUER (1994) surveys that covered large areas rarely found densities above 0.2 territories/100 ha; this would correspond to a homerange of 5 km².



Fig. 11: Sunny, steep, open and rocky forests form optimal habitat for the Grey-headed Woodpecker; Altaussee, Northern Limestone Alps. Photo: W. Weißmair.

Tab. 6: Comparison of large-scale abundances (territories/100 ha) of the Grey-headed Woodpecker from the Austrian Alpine region on contiguous plots from about 500 ha. In the own investigations only those with simultaneous acquisitions found input. Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria, Vbg=Vorarlberg, Ktn=Carinthia.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	0.5-0.6	current study
Nationalpark Kalkalpen	Oö	32.4	0.5-0.6	WEISSMAIR 2014
Vogelschutzgebiet Dachstein	Oö	14.2	0.49-0.56	WEISSMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	0.8	WEISSMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	13.39	0.9	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	0.31	TEUFELBAUER 2010
Nationalpark Gesäuse	Stmk	9.84	0.46	TEUFELBAUER et al. 2011
Nationalpark Gesäuse	Stmk	6.54	0.76	WIRTITSCH et al. 2013
Vogelschutzgebiet Karwendel	Tyrol	48	0.69-0.82	OBERWALDER et al. 2014
Karwendel Teilgebiet	Tyrol		0.76-0.9	OBERWALDER et al. 2014
Brandnerberg	Tyrol	5	0.6-0.7	PFANDL et al. 2004
Klostertal	Vbg	15	2.0	KILZER 1996
Vogelschutzgebiet Schütt-Dobratch	Ktn	46	0.3-0.4	WAGNER 2009

A seemingly interesting comparison can be made with the situation found outside the Alps in the Nationalpark Thayatal, Lower Austria. POLLHEIMER (2010) searched an area of 1330 ha of mostly steep and partly rocky terrain and obtained a density of 1.1 territories/100 ha.

Black Woodpecker (*Dryocopus martius*)

Status: Austrian Red List: Least Concern (FRÜHAUF 2005), EU: Appendix I.

In Austria, the Black Woodpecker is widespread and rather common species. In Upper-Austria it inhabits larger, continuous forests from the Danubian floodplain forests up to the Alpine tree line. It only avoids large stretches of treeless agricultural land and the alpine zone above the tree-line (DVORAK et al. 1993, STADLER 2003). Austrian populations are sizeable and stable or slightly increasing (FRÜHAUF 2005).

In the study area, this species inhabits a diverse range of forest types and uses various combinations of coniferous, mixed and deciduous forests. Ants and xylophagous insects, which are extracted from mature and dead wood, comprise its main food source. Black Woodpeckers excavate their nests mainly in strong and high boles of beech trees, rarely in other tree species. They occurred mainly between 700 and 1200 m in our study area (Fig. 9).

Black Woodpeckers defend only the breeding site within the homerange and the location at which they just happen to be against rivals. The distribution of breeding pairs largely depends on available nesting trees. Homeranges can overlap and be rather inhomogeneous. Nest cavity and feeding area can be kilometres apart (BLUME 1994, 1996).

This species is optically and acoustically very conspicuous. Estimates of their abundance tend therefore to be high or even too high; their large homeranges and their foraging movements across valleys have to be considered (cf. SCHERZINGER 1982).

In relation to the study area of 7,656 ha, Black Woodpecker densities in the Northern Limestone Alps of Styria and Upper Austria are relatively high and reach 0.4-0.5 territories/100 ha (Tab. 7); considering only those plots in which the species actually occurred these figures rise to 0.55-0.63 territories/100 ha. The highest densities obtained in the Nationalpark Kalkalpen and the Styrian Totes Gebirge, with about 0.6 Territories/100 ha and maxima up to 1 territory/100 ha (Spering), and somewhat lower values in the Dachstein area (Tab. 6), not considering the smaller plots.

HOCHBNER et al. (2015) found slightly higher densities (total area: 0.75 Territories/100 ha, plot Rothwald: 0.55 Territories/100 ha, plot Hundsau: 0.98 Territories/100 ha.), in the Ötscher-Dürrenstein region 2013 and 2014. However, their 12 plots were much smaller (81.2-148.7 ha, total area 1338.5 ha).

With 1.7 territories/100 ha, the Klostertal valley in Vorarlberg harboured remarkable numbers of Black



Fig. 12: Typical excavation marks of the Black Woodpecker. Photo: N. Pühringer.



Fig. 13: Black Woodpecker. Photo: W. Weißmair.

Tab. 7: Number of territories and abundances of the Black Woodpeckers on the 26 study plots in the Upper-Austria und Styria Northern Limestone Alps.

Study areas and plots	Area [ha]	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	3-4	0.6-0.8
Wilder Graben	497	3-4	0.6-0.8
Große Schlucht	309	2.5	0.8
Holzgraben	522	4	0.8
Spering-Lackerboden	314	3	1.0
Feichtau	490	-	-
Mayralm	577	1	0.2
Sub-total (all plots)	3242	16.5-18.5	0.50-0.57
Sub-total (plots with B Woodpeckers)	2852	16.5-18.5	0.57-0.64
Dachstein and Eibenberg / Upper Austria			
Lärchkogel	131	2	1.5
Hochalm	150	-	-
Modereckalm	132	-	-
Seekaralm	372	-	-
Scharwandhütte	100	-	-
Hirschbrunn-Kessel	96	1	1.0
Winkler Berg	151	1-2	0.7-1.3
Sulzgraben	110	1	0.9
Koppenwinkel	165	-	-
Eibenberg	163	1-2	0.6-1.2
Sub-total (all plots)	1569	6-8	0.4-0.5
Sub-total (plots with B Woodpeckers)	500	6-8	1.2-1.6
European Reserve Dachstein/Upper Austria			
Gosauseen	300	0.5	0.2
Seekaralm	300	0.5	0.2
Arikögele	300	0.5	0.2
Krippenbrunn	400	1.5	0.4
Schönbergalm	120	-	-
Sub-total (all plots)	1420	3	0.21
Sub-total (plots with B Woodpeckers)	1300	3	0.23
European Reserve Totes Gebirge/Styria			
Altaussee	380	2.5	0.7
Grundlsee	235	1-2	0.4-0.9
Schwarzenberg	430	2	0.5
Toplitzsee	380	2.5	0.7
Sub-total (all plots)	1425	8-9	0.6-0.7
Sub-total (plots with B Woodpeckers)	1425	8-9	0.6-0.7
Total (all plots)	7656	33.5-38.5	0.4-0.5
Total (plots with B Woodpeckers)	6077	33.5-38.5	0.55-0.63

Woodpeckers in a 15 km² old mountain forest in the mid 1990ties (KILZER 1996).

OBERWALDER et al. (2014) registered 0.32 territories/100 ha on seven plots (total area almost 4,800 ha) in the Tyrolian Karwendel mountains; considering only occupied plots the density was 0.39 territories/100 ha, comparable to the densities found in our study.

The three plots studied in the Nationalpark Gesäuse were obviously too small (approx. 300-400 ha, total 984 ha) for an analysis (TEUFELBAUER 2010, TEUFELBAUER et

Tab. 8: Comparison of large-scale abundances (territories/100 ha) of the Black Woodpecker from the Austrian Alpine region on contiguous plots from about 1000 ha. In the own investigations only those with simultaneous acquisitions found input; n.c.=not calculated. Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria, Vbg=Vorarlberg, Ktn=Carinthia.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	0.4-0.5	current study
Nationalpark Kalkalpen	Oö	32.4	0.6-0.7	WEIBMAIR 2014
Dachstein and Eibenberg	Oö	15.7	0.4-0.5	GIGL & WEIBMAIR 2009
Vogelschutzgebiet Dachstein	Oö	14.2	0.2	WEIBMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	0.6-0.7	WEIBMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	10.88	0.83	FRANK & HOCHBNER 2001
Wildnisgebiet Dürrenstein	Nö	13.39	0.75	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	n.c.	TEUFELBAUER 2010
Nationalpark Gesäuse	Stmk	9.84	n.c.	TEUFELBAUER et al. 2011
Nationalpark Gesäuse	Stmk	6.54	0.61	WIRTITSCH et al. 2013
Vogelschutzgebiet Karwendel Tyrol		48	0.32	OBERWALDER et al. 2014
Karwendel Teilgebiet	Tyrol		0.39	OBERWALDER et al. 2014

al. 2011); WIRTITSCH et al. (2013), however, succeeded and calculated a density of 0.61 Territories/100 ha based on two plots there (total 654 ha).

DVORAK (2009) reported 0.3 Territories/100 ha for 45.5 km² forest in the IBA Northeastern Leithagebirge; very similar densities, 0.3-0.4 territories/100 ha in

46 km² forest, were found in the IBA Villacher Alpe-Dobratsch (WAGNER 2009).

SCHERZINGER (1982) estimated territory sizes of 373-567 ha in 130 km² of the National Park Bavarian Forest (corresponds to approx. 0.2 territories/100 ha); considering suitable habitats only the estimates were 258-393 ha for territory size or 0.25-0.38 territories/100 ha for the density. The Black Woodpecker preferred northeast facing slopes at elevations between 1100 and 1200 m in the Nationalpark Berchtesgaden (PECHACEK 1995). The densities there, computed for a large area, were at 0.25 pairs/100 ha, about half of what was found in our studies.

Large scale densities in Switzerland were mostly below 0.25 territories/ 100 ha, corresponding to a territory size of 400 ha (MAUMARY et al. 2007). According to GLUTZ VON BLOTZHEIM & BAUER (1994) too, a pair commonly engrosses a forest area of approx. 300-400 ha. Locally and under optimal conditions, territories can be as small as 100 ha. RUGE & BRETZENDORFER (1981) report territory sizes of 250 ha in optimal habitats (corresponds to 0.4 territories/100 ha) which expand to 550-700 ha in unfavorable habitats (approx. 0.2 territories/100 ha).

White-backed Woodpecker (*Dendrocopos leucotos*)

Status: Austrian Red List: Near Threatened (FRÜHAUF 2005), EU: Appendix I.

The White-backed Woodpecker breeds at low densities across Austria from the Vienna Woods to Vorarlberg close to its western limit in Central Europe. The montane deciduous and mixed forests of the Northern Limestone zone constitute its stronghold there. As far as we know, in Upper Austria, it is mainly found in the foothills of the Alps and the limestone mountains, from the Dachstein North to about the 48° latitude. The region between the Salzkammergut and the Ennstaler Alps is probably inhabited continuously wherever suitable forests exist. In this core area, the species occurs at altitudes between 400 and 1400 m, mainly between 600 and 1200 m. Current estimates indicate stable populations at least in optimal habitats, beech and mixed forests little influenced by forestry, between the upper Traun valley and the Totes Gebirge, and between the Nationalpark Kalkalpen (Sengengebirge, Reichraminger Hintergebirge) and the mountains of the Ennstal, respectively. There is little knowledge about occurrences in the Kobernauberwald or the forests of the Hausruck. The hills between Irrsee, Mondsee and Wolfgangsee are probably also inhabited. A record remarkable with respect to habitat in the riverine forest of the upper Danube valley by W. CHRISTL suggests that



Fig. 14: White-backed Woodpecker. Photo: W. Weißmaier.

this woodpecker may also breed in the steep and hardly accessible slopes along the upper Danube. Only a few old records exist from the Bohemian massif and a search focused on this species there would be welcome (WEIB-MAIR 2014).

The White-backed Woodpecker is considered a specialist of pristine forests and indeed requires mature deciduous or mixed forests with a high amount of dead wood. Intensively exploited commercial forests do not fulfil these requirements. Extant populations of the White-backed Woodpecker are therefore mostly restricted to steep slopes and other areas that are difficult to exploit by forestry. An analysis of 110 exactly located observations in the Nationalpark Kalkalpen showed that they refer to 60 to 235 years old stands, with a mean of 155 years. A rich supply of xylophagous insects (e.g. long-horned beetles) is necessary for this „excavater“. Several observations evidence that fir and spruce trees heavily infested with bark beetles may also be used. Roosts and nests are excavated in fully or partially dead trees (mainly beech and sycamore maple) exclusively. The altitudinal distribution of the species is shown in Fig. 9.

Relatively high densities of 0.6 to 0.7 territories/100ha were found over a larger area (26 plots totalling 7,656 ha) in the Upper Austrian and Styrian Limestone Alps (Tab. 9). Considering only plots in which the species actually occurred (area total 4,062 ha), densities were as high as 1.0-1.28 territories/100 ha. The by far highest densities were reached in old mixed forest stands with lots of dead wood in the Nationalpark Kalkalpen where on 3,242 ha, inclusively less suitable areas, densities between 1.0-1.1 territories/100 ha were found. In comparably large areas in Austria and neighbouring countries, only the Dürnststein wildernis area reaches such densities (FRANK & HOCHBNER 2001, HOCHBNER et al. 2015; Tab. 11, 12). The four plots suitable for the species, namely Bodinggraben, Wilder Graben, Holzgraben and Große Schlucht in the Reichraminger Hintergebirge (1,861 ha in total, Tab. 10) hold with 6-10 territories each (total 28-34) remarkable populations. The corresponding densities were 1.5-1.87 territories/100 ha (Tab. 10) and over this large area significantly higher as in the Dürrenstein wildernis. There, HOCHBNER et al. (2015) found on significantly smaller plots and a total area of 1,338.5 ha a density of 1.34 territories/100 ha (Tab. 11).

The maximal density (1.9-2.3 territories/100 ha, Tab. 10) was found in the 309 ha „Große Schlucht“ (Nationalpark Kalkalpen); territories there occupy an area of 50 ha on average. On smaller plots, densities were even higher, of course: Scheiterkogel (120 ha; 2.9 Territories/100 ha), „Schnäpperleiten“ in the Wilder

Tab. 9: Number of territories and abundances of the White-backed Woodpecker on the 26 study plots in the Upper-Austria and Styria Northern Limestone Alps.

Study areas and plots	Area [ha]	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	7.5-8.5	1.4-1.6
Wilder Graben	497	7.5-10.5	1.5-2.1
Große Schlucht	309	6-7	1.9-2.3
Holzgraben	522	7-8	1.3-1.5
Spering-Lackerboden	314	1	0.3
Feichtau	490	1	0.2
Mayralm	577	1	0.3
Sub-total (all plots)	3242	31-37	1.0-1.1
Sub-total (plots with W-b Woodpeckers)	1.0-1.1	3242	31-37
Dachstein and Eibenberg/Upper Austria			
Lärchkogel	131	-	-
Hochalm	150	-	-
Modereckalm	132	-	-
Seekaralm	372	-	-
Scharwandhütte	100	-	-
Hirschbrunn-Kessel	96	-	-
Winkler Berg	151	-	-
Sulzgraben	110	-	-
Koppenwinkel	165	-	-
Eibenberg	163	-	-
Sub-total (all plots)	1569	-	-
European Reserve Dachstein/Upper Austria			
Gosauseen	300	1-2	0.3-0.6
Seekaralm	300	-	-
Arikögele	300	-	-
Krippenbrunn	400	1	0.25
Schönbergalm	120	1	0.8
Sub-total (all plots)	1420	3-4	0.2-0.3
Sub-total (plots with W-b Woodpeckers)	0.36-0.48	820	3-4
European Reserve Totes Gebirge/Styria			
Altausee	380	3	0.8
Grundlsee	235	1-2	0.4-0.9
Schwarzenberg	430	1.5	0.3
Toplitzsee	380	4-5	1.2
Sub-total (all plots)	1425	10-11	0.7
Total (all plots)	7656	44-52	0.6-0.7
Total (plots with W-b Woodpeckers) 4062		44-52	1.0-1.28

Tab. 10: Number of territories and abundances of the White-backed Woodpecker on the four deciduous or mixed forest study plots in Reichraminger Hintergebirge, Nationalpark Kalkalpen 2009-2011.

Plot	Area (ha)	N-Territories	Territories/100 ha
Bodinggraben	533	7.5-8.5	1.4-1.6
Wilder Graben	497	7.5-10.5	1.5-2.1
Große Schlucht	309	6-7	1.9-2.3
Holzgraben	522	7-8	1.3-1.5
Total	1861	28-34	1.5-1.87



Fig. 15: Because of its old, dead wood rich beech forest, the Wilder Graben harbours a very good and dense White-backed Woodpecker population. Photo: W. Weißmair.

Tab. 11: Comparison of large-scale abundances (territories/100 ha) of the White-backed Woodpecker from the Austrian Alpine region on contiguous plots from about 1000 ha. In the own investigations only those with simultaneous acquisitions found input. Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria, Vbg=Vorarlberg.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	0.6-0.7	current study
Nationalpark Kalkalpen gesamt	Oö	32.4	1.0-1.1	WEIßMAIR 2014
Nationalpark Kalkalpen Reichraminger Hintergebirge	Oö	18.61	1.5-1.87	WEIßMAIR 2014
Vogelschutzgebiet Dachstein	Oö	14.2	0.2-0.3	WEIßMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	0.7	WEIßMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	10.88	1.56	FRANK & HOCHBNER 2001
Wildnisgebiet Dürrenstein	Nö	13.39	1.34	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	0.09	TEUFELBAUER 2010
Nationalpark Gesäuse	Stmk	9.84	0.3	TEUFELBAUER et al. 2011
Vogelschutzgebiet Karwendel	Tyrol	48	0.12	OBERWALDER et al. 2014
Karwendel Teilgebiet	Tyrol		0.26	OBERWALDER et al. 2014
Klostertal	Vbg	15	0.7	KILZER 1996

Tab. 12: Comparison of abundances (territories/100 ha) of the White-backed Woodpecker in the forest areas of Europe. D=Germany, PL=Poland, H=Hungary, NP=National Park.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nationalpark Bayerischer Wald	D	13041	0.04-0.06	SCHERZINGER 1982
NP Białowieś	PL	4750	0.60	WESOŁOWSKY 1995
NP Białowieś	PL	1000	1.00	WESOŁOWSKY 1995
Börzsöny, Pilsengebirge				
(disjunct plots with 100 ha each)	H	1200	1.1	NAGY et al. 2008

Graben (7 territories on 250 ha, equaling 2.8 territories/100 ha), south facing slopes of the Astein-Quenkogel (210 ha, 2.4 territories/100 ha); individual territories measure only 30 ha plus there. HOCHBNER et al. (2015) report a maximal density of 2.04 territories/100 ha for the 97.9 ha plot „Großer Urwald-Gindelstein“.

In his thesis, FRANK (2001) studied the White-backed Woodpecker and its niche partitioning with the Great Spotted Woodpecker in the montane mixed forests of the Northern Limestone Alps (Ötscher-Dürrenstein, Lower Austria) in great detail. He found a density of 1.38 territories/100 ha in an area of 5,094 ha, on optimal sub-plots in the Rothwald primeval forest 1.35-2.57 territories/100 ha, corresponding to the somewhat lower to comparable densities found in the Nationalpark Kalkalpen. One has to consider here that FRANK (2001) based his results on plots that were 160 ha on average and hence smaller resulting inevitably in somewhat higher density estimates. The White-backed Woodpecker together with the Great Spotted Woodpecker were the most common members of the woodpecker fauna and the former was even the dominant species in the primeval Rothwald forest (FRANK 2001, FRANK & HOCHBNER 2001).

TEUFELBAUER (2010) estimated a density of only 0.09 territories/100 ha for the Nationalpark Gesäuse. Subsequently and based on a survey of 984 ha, the estimate for this region was 0.3 territories/100 ha, and WIRTITSCH et al. (2013) searched an area of 654 ha and found 0.38 territories/100 ha.

KILZER (1996) found rather low densities of the White-backed Woodpecker, namely 0.7 territories/100 ha, in a 15 km² old forest (including old deciduous forest) in the Klostertal in Vorarlberg in the mid-nineties.

The densities of the White-backed Woodpecker were low in the Tyrolian Karwendel (OBERWALDER et al. 2014), the average of all plots (totalling almost 4,800 ha) was only 0.12 territories/100 ha (maximum was 0.27 territories/100 ha, in the Vomperloch. Although the average of only those plots in the Karwendel that were suitable for the species was with 0.26 territories/100 ha considerably higher, compared with other bird conservation areas in the Alps it was still low and closest to the values found in the Gesäuse Nationalpark.

For the sake of comparison, densities in a larger area outside the Alps should be mentioned. POLLHEIMER (2010) found a density of 0.3 territories/100 ha in the Nationalpark Thayatal (Northern Lower Austria). The habitat there comprises deciduous forest on steep, partially rocky slopes on an area of 1,330 ha.



Fig. 16: Great Spotted Woodpecker. Photo: N. Pühringer.

Great Spotted Woodpecker (*Dendrocopos major*)

Status: Austrian Red List: Least Concern (FRÜHAUF 2005).

The Great Spotted Woodpecker is the most common and most widely distributed woodpecker of both Austria and Upper Austria. It inhabits the lowlands and valley bottoms as well as habitats at the alpine treeline, although densities are low in the latter. Abundances peak in old growth forests with a high proportion of oak and in which territory sizes are 5-10 ha only (GLUTZ VON BLOTZHEIM & BAUER 1994, BACHMANN & PASINELLI 2002). Great Spotted Woodpeckers utilize a great variety of woodland habitats; at least some older trees for roosts and nest must be present. In contrast to the Three-toed Woodpecker, the Great Spotted Woodpecker not only feeds on animal matter, but also heavily on various types of seeds. Spruce seeds, in particular, play a decisive role in mountain forests that offer little other food sources in winter (SCHERZINGER 1982). All these adaptations allow them to reach high abundances even in forest stands with little dead wood. Compared with the Three-toed Woodpecker, the Great Spotted Woodpecker, because of its adaptability, can utilize Larch and Larch-Stone pine forests close to the treeline more efficiently and at higher densities. Due to its broad niche, the Great Spotted Woodpecker was the species that was most uniformly spread over the whole altitudinal range of the study plots (Fig. 9).

Tab. 13: Number of territories and abundances of the Great Spotted Woodpecker on the 26 study plots in the Upper-Austria and Styria Northern Limestone Alps.

Study area and plots	Area (ha)	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	13.5-14.5	2.5-2.7
Wilder Graben	497	4.5-7.5	0.9-1.5
Große Schlucht	309	4-5	1.3-1.6
Holzgraben	522	6-9	1.1-1.7
Spering-Lackerboden	314	5.5-7.5	1.8-2.4
Feichtau	490	9-11	1.8-2.2
Mayralm	577	10.5-12.5	1.8-2.2
Sub-total (all plots)	3242	53-67	1.6-2.1
Sub-total (plots with G S Woodpeckers)		3242	53-67
Dachstein and Eibenberg/Upper Austria			
Lärchkogel	131	3	2.3
Hochalm	150	-	-
Modereckalm	132	-	-
Seekaralm	372	2-3	0.5-0.8
Scharwandhütte	100	-	-
Hirschbrunn-Kessel	96	1-2	1.0-2.0
Winkler Berg	151	2	1.3
Sulzgraben	110	-	-
Koppenwinkel	165	-	-
Eibenberg	163	1	0.6
Sub-total (all plots)	1569	9-11	0.6-0.7
Sub-total (plots with GS Woodpeckers)	913	9-11	1.0-1.2
European Reserve Dachstein/Upper Austria			
Gosauseen	300	-	-
Seekaralm	300	4-6	1.3-2.0
Arikögele	300	3.5	1.2
Krippenbrunn	400	5.5-7.5	1.4-1.9
Schönbergalm	120	2	1.7
Sub-total (all plots)	1420	15-19	1.0-1.3
Sub-total (plots with G S Woodpeckers)		1120	15-19
1.3-1.7			
European Reserve Totes Gebirge/Styria			
Altausee	380	7-8	1.8-2.1
Grundlsee	235	3.5	1.5
Schwarzenberg	430	6	1.4
Toplitzsee	380	2.5	0.7
Sub-total (all plots)	1425	19-20	1.4
Sub-total (plots with G S Woodpeckers)		1425	19-20
1.4			
Total (all plots)	7656	96-117	1.3-1.5
Total (plots with G S Woodpeckers)	6700	96-117	1.4-1.7

In the mountain forests of the Upper Austrian and Styrian Northern Limestone Alps, the Great Spotted Woodpecker occurs at densities of 1.3 to 1.5 territories/100 ha when computed over all plots (7,656 ha; Tab. 13); considering only those plots in which the species actually was found, the value was 1.4-1.7 territories/100 ha. Most Great Spotted Woodpecker territories were found in the Nationalpark Kalkalpen plots (1.6-

Tab. 14: Comparison of large-scale abundances (territories/100 ha) of the Great Spotted Woodpecker from the Austrian Alpine region on contiguous plots from about 1000 ha. In the own investigations only those with simultaneous acquisitions found input. Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	1.3-1.5	current study
Nationalpark Kalkalpen gesamt	Oö	32.4	1.6-2.1	WEIBMAIR 2014
Dachstein and Eibenberg	Oö	15.69	0.6-0.7	GIGL & WEIBMAIR 2009
Vogelschutzgebiet Dachstein	Oö	14.2	1.0-1.3	WEIBMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	1.3-1.5	WEIBMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	13.39	0.22	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	0.72	TEUFELBAUER 2010

2.1 territories/100 ha) and surprisingly about as common as the Three-toed Woodpecker. It too profited from the current rich supply of bark beetles and other dead wood inhabiting xylophagous insects. Not fewer than 5.5 territories were detected on a 60 ha section of spruce forest (Scheiterkogel) heavily infested with bark beetles, corresponding to 9.2 territories/100 ha, five times as much as elsewhere. With 6-7 territories/100 ha, the density was significantly above average in bark beetle infested patches in the central Feichtaualm too.

TEUFELBAUER (2010) found a density of 0.72 territories/100ha in the Nationalpark Gesäuse (11.11 km² surveyed) which is considerably below the values in our study are (Tab. 14). In a subsequent study, TEUFELBAUER et al. (2011) searched an area of 984 ha in which the

Great Spotted Woodpecker only was represented as foraging visitor or with partial territories, and the monitoring by WIRTITSCH et al. (2013) resulted in only two occupied plots (654 ha in sum) with a density of 0.3 territories/100 ha.

In the Dürrenstein wilderness area, the Great Spotted Woodpecker was with only 0.22 territories/100 ha surprisingly rare (HOCHBNER et al. 2015) despite the similar forest types and elevation profile as in this study.

PECHACEK (1995) found with 0.74 breeding pairs/km² over a large section of the Nationalpark Berchtesgaden lower densities than those reported here for the Northern Limestone Alps of Upper Austria and Styria.

Eurasian Green Woodpecker (*Picus viridis*)

Status: Austrian Red List: Least Concern (FRÜHAUF 2005).

The Eurasian Green Woodpecker is widely distributed in Austria, absent only in agricultural areas with few trees and in the Alpine zone. In Upper Austria, it occurs mainly in semi-open landscapes from the lower parts of the Bohemian massif, the Danube valley to the Flysch zone; it avoids larger closed forests, spreads far into Alpine valleys along the rivers Traun, Steyr and Enns staying, however, mostly at their bottoms (DVO-RAK et al. 1993, STADLER 2003). It prefers altitudes up to 1220 m, but may, for instance, breed under continental climatic conditions as high as 2120 m in the Wallis, Switzerland (BLUME 1994, 1996). Being a ground woodpecker, this species requires meadows and pastures rich in ants, its main food. It mainly uses old deciduous trees for nesting. Winters with much snow and rainy springs lead to substantial losses and strong population fluctuations, respectively (BLUME 1994, 1996). Due to its strong association with ants, the Green Woodpecker occurred exclusively in very open and south facing forest stands in our study area. On those slopes that were occupied, one always could find larger open patches in the form of clearings or windfall areas. During the winter, snow quickly disappears in avalanche swaths and open forest patches interspersed with rocks. The extensive alpine pastures in the Dachstein massif, Totes Gebirge, and the Nationalpark Kalkalpen, however, harbour surprisingly few territories of this species, possibly because of their long lasting snow cover.

The Green Woodpecker breeds only sparsely in the mountain forests of the Northern Limestone Alps of Upper Austria and Styria (Tab. 15). Deep snow cover seemingly constrains the use of the few available habitats further. With just one territory, the Green Woodpecker was unexpectedly rare even in the open, low



Fig. 17: Eurasian Green Woodpecker. Photo: N. Pühringer.

montane grassland of the plot Große Schlucht in the Nationalpark Kalkalpen. Based on all plots in the Nationalpark Kalkalpen (3,242 ha), the density was just 0.15 territories/100 ha, 0.2 territories/100 ha based on all plots in the Northern Limestone Alps, increasing to 0.4 territories/100 ha when only the occupied plots were considered.

The situation was rather similar in the Tyrolian Karwendel where OBERWALDER et al. (2014) estimated an average density of 0.41 territories/100 ha based on seven plots (total area almost 4,800 ha), not all of them occupied (Tab. 16). The densities ranged from 0.14 to 1.04 territories/100 ha. Lower densities were found in 14 km² of the European conservation area Dachstein, namely 0.07 territories/100 ha (WEIBMAIR & PÜHRINGER 2011, Tab. 15).

TEUFELBAUER (2010) found with 0.18 territories/100 ha a density similar to our study area in the Nationalpark Gesäuse. Based on a subsequent study of 948 ha, they reported a slightly higher density of 0.3 territories/100 ha. Later, WIRTITSCH et al. (2013) detected even 0.6 territories/100 ha. However, he based his estimate on two plots comprising a total size of only 654 ha.

In the Dürrenstein wildernis, the Green Woodpecker was limited to the westernmost part in the years 2013 and 2014, as already before in 1999 and 2000. The 2013/14 densities, 0.33 territories/100 ha for the Hundsau plot (388) or 0.15 territories/100 ha for the total area (1,088 ha), agree largely with those found 1999/2000, with 0.26 territories/100 ha for the Hundsau and 0.09 territories/100 ha for the total area (HOCHBNER et al. 2015), and are comparable with those found in our study. WAGNER (2009) reported also a low density, 0.15 territories/100 ha, for the bird reserve Schütt-Dobratsch in Carinthia

KILZER (1996) found with 1.4 territories/100 ha, significantly higher densities in the Klostertal, Vorarlberg. Such densities compare well with those found in the hills north of the Alps: SCHUSTER (1997) detected 18 to 22 territories in an area of about 2,000 ha in the lower Traun valley, corresponding to a territory size of about 100 ha. A study on woodpecker densities based on ten plots (28 km²), the ORNITHOLOGISCHE ARBEITSGEMEINSCHAFT came up with remarkable densities for those plots that contained substantial proportions of Greenland. The Green Woodpecker reached densities between 1 to 1.5 territories/100 ha in seven plots, 1.1-1.2 territories/100 ha on average. It occupied 1.7-2.1 territories/100 ha on a 600 ha plot in Garsten (WEIBMAIR 2011a).

Tab. 15: Number of territories and abundances of the Green Woodpecker on the 26 study plots in the Upper-Austria and Styria Northern Limestone Alps.

Study area and plots	Area (ha)	N-Territories	Territories/100 ha
Nationalpark Kalkalpen			
Bodinggraben	533	-	-
Wilder Graben	497	1.5	0.3
Große Schlucht	309	1	0.3
Holzgraben	522	-	-
Spering-Lackerboden	314	1	0.3
Feichtau	490	1-2	0.2-0.4
Mayralm	577	-	-
Sub-total (all plots)	3242	4.5-5.5	0.14-0.17
Sub-total (plots with G Woodpeckers)	1610	4.5-5.5	0.28-0.34
Dachstein and Eibenberg/Upper Austria			
Lärchkogel	131	-	-
Hochalm	150	-	-
Modereckalm	132	-	-
Seekaralm	372	-	-
Scharwandhütte	100	-	-
Hirschbrunn-Kessel	96	1	1.0
Winkler Berg	151	-	-
Sulzgraben	110	-	-
Koppenwinkel	165	-	-
Eibenberg	163	-	-
Sub-total (all plots)	1569	1	0.06
Sub-total (plots with G Woodpeckers)	96	1	1.0
European Reserve Dachstein/Upper Austria			
Gosauseen	300	-	-
Seekaralm	300	0.5	0.2
Arikögele	300	0.5	0.2
Krippenbrunn	400	-	-
Schönbergalm	120	-	-
Sub-total (all plots)	1420	1	0.07
Sub-total (plots with G Woodpeckers)	600	1	0.16
European Reserve Totes Gebirge/Styria			
Altaussee	380	2	0.5
Grundlsee	235	2.5	1.0
Schwarzenberg	430	2	0.5
Toplitzsee	380	2	0.5
total/densities all plots	1425	8.5	0.6
plots species occurred	1425	8.5	0.6
Total (all plots)	7656	15-16	0.2
Total (plots with G Woodpeckers)	3731	15-16	0.4

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Tab. 16: Comparison of large-scale abundances (territories/100 ha) of the Green Woodpecker from the Austrian Alpine region on contiguous plots from about 1000 ha. In the own investigations only those with simultaneous acquisitions found input; Oö=Upper Austria, Stmk=Styria, Nö=Lower Austria, Vbg=Vorarlberg.

Study area	Province	Area (km ²)	Territories /100 ha	Reference
Nördliche Kalkalpen	Oö/Stmk	76.56	0.2	current study
Nationalpark Kalkalpen gesamt	Oö	32.4	0.15	WEIßMAIR 2014
Vogelschutzgebiet Dachstein	Oö	14.2	0.07	WEIßMAIR & PÜHRINGER 2011
Vogelschutzgebiet steirisches Totes Gebirge	Stmk	14.25	0.6	WEIßMAIR & PÜHRINGER 2012
Wildnisgebiet Dürrenstein	Nö	13.39	0.15	HOCHBNER et al. 2015
Nationalpark Gesäuse	Stmk	11.11	0.18	TEUFELBAUER 2010
Nationalpark Gesäuse	Stmk	9.84	0.3	TEUFELBAUER et al. 2011

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Zusammenfassung

Innerhalb Österreichs herrschte bis vor kurzem ein erheblicher Mangel an großflächigen Bestandserfassungen im alpinen Raum. Das betrifft in erster Linie methodisch schwer erfassbare Arten wie Eulen oder besonders auch die Spechte. Ziel der Untersuchungen war es, für die verschiedenen Gebirgsstöcke repräsentative Daten auf großer Fläche zu bekommen, um erstmals seriöse Grundlagen für Hochrechnungen und überregionale Bestandsschätzungen zu erhalten. Gerade bei den alpinen Spechten zeigte sich, dass die Bestände bislang gravierend falsch eingeschätzt worden waren. Da der überwiegende Teil der untersuchten Gebiete in Großschutzgebieten liegt, bestand hier auch seitens der Naturschutzbehörden erheblicher Bedarf. Vier der sechs alpinen Spechtarten sind zudem im Anhang 1 der EU-Vogelschutzrichtlinie gelistet.

Als quantitative Erfassungsmethode kam die rationalisierte Revierkartierung auf 26 Probeflächen zum Einsatz. Die Erhebungen fanden im Zeitraum 2005-2011 statt. Die Probeflächen lagen in den Gebirgsstöcken Dachstein (Europaschutzgebiet, Oberösterreich) bzw. am Eibenberg in Ebensee, dem Nationalpark Kalk-

alpen (Europaschutzgebiet, Oberösterreich) und dem Toten Gebirge (Europaschutzgebiet, Steiermark) in den Nördlichen Kalkalpen, und umfassten insgesamt 7656 ha. Die Größen der einzelnen Probeflächen lagen am Dachstein und Eibenberg im Jahr 2005 zwischen 96 und 372 ha (Summe 1569 ha), am Dachstein 2006 und 2007 bei 120-400 ha (Summe 1420 ha), im Nationalpark Kalkalpen 2009-2011 bei 309-577 ha (Summe 3242 ha) und im Steirischen Toten Gebirge 2009 und 2011 bei 235-430 ha (Summe 1425 ha). Innerhalb der Schutzgebiete wurde jeweils versucht, die Probeflächen hinsichtlich Waldtypen, Seehöhe, Neigung und Exposition möglichst repräsentativ auszuwählen.

In der Regel wurden die Kartierungen an zwei Tagen mit Übernachtungen im Gebiet durchgeführt. Besonders wichtig waren die Simultankartierungen! Dazu bearbeiteten – je nach Flächengröße – zwei bis sieben Personen gleichmäßig verteilt, simultan eine Probefläche, was die Gefahr von Doppelzählungen weitgehend ausschließen sollte. Es erfolgten Tagbegehungen, besonders aber Erfassungen in den Morgen- und Vormittagsstunden. Beim Ausbleiben spontaner Aktivität in geeignet erscheinenden Lebensräumen wurden auch Klammgattungen eingesetzt.

In Oberösterreich und der Steiermark sind alle 10 europäischen Spechtarten vertreten. Kleinspecht (*Dryobates minor*), Mittelspecht (*Leiocopus medius*), Blutspecht (*Dendrocopos syriacus*) und Wendehals (*Jynx torquilla*) sind jedoch weitgehend auf die Tieflagen beschränkt. Diese Arten konnten im Bergwald im Zuge der Kartierungsarbeiten daher naturgemäß nicht festgestellt werden. Die sechs „Bergwaldspechte“ Grau-, Grün-, Schwarz-, Bunt-, Weißrücken- und Dreizehenspecht konnten dagegen in allen untersuchten Gebieten – wenn auch nicht in jeder Probefläche – teils in sehr hohen Dichten nachgewiesen werden.

Der **Dreizehenspecht** weist eine sehr enge Bindung an die Fichte auf und kann als Charakterart alter, totholzreicher Fichtenwälder und fichtenreicher Mischwälder im natürlichen Verbreitungsgebiet der Fichte bezeichnet werden. Er zeigt eine Bevorzugung von Nadelwäldern zwischen etwa 1000 und 1500 m Seehöhe. Auf der gesamten Untersuchungsfläche von 7656 ha konnten Dichten von 1,3-1,5 Reviere/100 ha gefunden werden, nur auf den Probeflächen mit Nachweisen (6930 ha) waren es sogar 1,4-1,7 Reviere/100 ha, also deutlich über dem (laut Literatur und eigener Erfahrung) Erwartungswert von etwa 1 Revier/100 ha. Im Nationalpark Kalkalpen erreichte er eine großflächig hohe Abundanz von 1,7-1,9 Reviere/100 ha. In den Optimalhabitaten, alten stark von Borkenkäfer befallenen montanen Alm-fichtenwäldern wurden sogar enorme Dichten von 3-3,5 Reviere/100 ha ermittelt, Spitzenwerte für

Mitteleuropa. Die teilweise außergewöhnlich hohen Dichten sind mit einem enorm hohen Angebot an Fichten mit Borkenkäferbefall infolge von starken Stürmen der Jahre 2005–2007 erklärbar. Im Wildnisgebiet Dürrenstein fanden HOCHBNER et al. (2015) auf der Gesamtfläche von 13,38 km² vergleichbare Siedlungsdichten von 1,42 Reviere/100 ha, OBERWALDER et al. (2014) im Karwendel auf fast 48 km² eine durchschnittliche Dichte von 0,75–0,77 Territorien/100 ha und im Nationalpark Gesäuse waren es auf 11,11 km² bis zu 1,03 Reviere/100 ha (TEUFELBAUER 2010).

Der **Grauspecht** bevorzugte südseitige, offene Mischwälder, oft auch mit eingestreuten Felsbereichen, von den tiefen Lagen bis etwa 1200 m Seehöhe. In Summe konnten auf 7656 ha Dichten von 0,5–0,6 Reviere /100 ha ermittelt werden. Im Nationalpark Kalkalpen lag die Siedlungsdichte bei ebenfalls 0,5–0,6 Reviere /100 ha. kleinräumig konnten aber am Dachstein und im Toten Gebirge auch Dichten von bis zu 1,1 Reviere /100 ha ermittelt werden. Höhere Werte werden von HOCHBNER et al. (2015) mit 0,9 Reviere /100 ha aus dem Wildnisgebiet Dürrenstein angegeben. OBERWALDER et al. (2014) fanden im Karwendel Grauspechtdichten von 0,69–0,82 Reviere /100 ha.

Durch die sehr großen Raumansprüche und Nahrungsflüge über große Distanzen, sowie seine optische und akustische Präsenz sind Bestandserfassungen beim **Schwarzspecht** im Vergleich zu anderen Spechtarten schwierig und oft mit Fehlern behaftet (Bestandsüberschätzung bei zu kleinen Probestichen!). Der Schwerpunkt der eigenen Nachweise lag in Laub- und Mischwäldern zwischen 700 und 1200 m Seehöhe, in Summe konnte in allen Untersuchungsgebieten 0,4–0,5 Reviere /100 ha gefunden werden. Im Nationalpark Kalkalpen konnte eine großflächige Siedlungsdichte von 0,5–0,6 Reviere /100 ha festgestellt werden, auf einzelnen Probestichen aber auch 0,8–1,0 Reviere /100 ha. Im Steirischen Toten Gebirge wurden gesamt Dichten von 0,6–0,7 Reviere /100 ha gezählt. Vergleichbar hohe Werte ermittelten HOCHBNER et al. (2015) mit 0,75 für das Wildnisgebiet Dürrenstein. Im Nationalpark Gesäuse fand WIRTITSCH et al. (2013) 0,61 Reviere /100 ha, im Klostertal KILZER (1996) jedoch sehr hohe Dichten von 1,7 Reviere /100 ha.

Der **Weißbrückenspecht** gilt wegen seiner Habitatansprüche als „Urwaldspezialist“. Besonders zur Brutzeit ist er auf alte, gut besonnte, lichte und besonders totholzreiche und daher insektenreiche Laubwälder oder Mischwälder angewiesen. Der Verbreitungsschwerpunkt lag in den Untersuchungsgebieten zwischen 600 und 1200 m Seehöhe, im gesamten Untersuchungsgebiet konnten Dichten von 0,6–0,7 Reviere /100 ha gefunden werden. Im Nationalpark Kalkalpen waren großflächige

Dichte von 1,0–1,1 Reviere /100 ha vorhanden, im optimal geeigneten Teilbereich Reichraminger Hintergebirge aber 1,5–1,87 Reviere /100 ha (auf 1861 ha), kleinflächig am Scheiterkogel auf 120 ha sogar bis zu 2,9 Reviere /100 ha. Am Dachstein ist der Weißbrückenspecht mangels Laubwäldern selten, im Europaschutzgebiet konnten nur 0,2–0,3 Reviere /100 ha ermittelt werden. Auch im Europaschutzgebiet Steirisches Totes Gebirge ist der Laubwaldanteil relativ gering, hier wurden 0,6–0,7 Reviere /100 ha ermittelt. Vergleichbare bzw. etwas niedrigere Dichten wie im Nationalpark Kalkalpen sind großflächig in Mitteleuropa nur noch aus dem Wildnisgebiet Dürrenstein bekannt (FRANK & HOCHBNER 2001, HOCHBNER et al. 2015: 1,56 bzw. 1,34 Reviere /100 ha).

Der **Buntspecht** ist die häufigste und am weitesten verbreitete Spechtart in Österreich und war auch in den Untersuchungsgebieten meist die häufigste Art. Er war auch über alle Höhenstufen recht gleichmäßig verteilt und konnte in Summe auf allen Probestichen mit 1,3–1,5 Reviere /100 ha nachgewiesen werden. Im Nationalpark Kalkalpen wurden großflächig mit 1,6–2,1 Reviere /100 ha die höchsten Dichten ermittelt. In vergleichbaren alpinen Untersuchungsgebieten ist der Buntspecht deutlich seltener, so fanden TEUFELBAUER (2010) im Gesäuse nur 0,72 Reviere /100 ha und HOCHBNER et al. (2015) im Wildnisgebiet Dürrenstein nur 0,22 Reviere /100 ha.

Aufgrund mangelnder Lebensraumeignung war der **Grünspecht** durchwegs in allen untersuchten Gebieten die seltenste Spechtart. Die schneereichen Berglagen schränken offenbar die Nahrungsverfügbarkeit besonders im Winter stark ein. Typisch war sein Auftreten an südseitigen und sehr lichten Waldbeständen mit hoher Ameisendichte. Großflächig war er in Summe aller Untersuchungsgebiete nur mit 0,2 Reviere /100 ha vertreten. Im Nationalpark Kalkalpen war der Grünspecht ebenfalls nur mit einer Dichte von etwa 0,15 Reviere /100 ha vertreten. Im Steirischen Toten Gebirge wurden höhere Dichten von 0,6 Reviere /100 ha gezählt. Im Vogelschutzgebiet Karwendel siedelte der Grünspecht mit 0,41 Reviere /100 ha (OBERWALDER et al. 2014). Die mit Abstand höchsten Dichten beim Grünspecht ermittelte KILZER (1996) im Klostertal/Vorarlberg mit 1,4 Reviere /100 ha.

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